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THE OHIO JOURNAL OF SCIENCE

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CERTIFICATES OF GROWING UP AND GROWING OLD*

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and Associated Foundations

Growing is a subject for comment and congratulation. No child but revels in growth so vigorous that clothes have missed their chance of wearing out. Even if growth is measured in terms of weight, it is dimension not tonnage which gives pride and satisfaction. So dear to our hearts are the thoughts of our childhood that this one never fades and growth remains increase in dimension in all our natural ambition. With some misgivings and a trace of regret we force ourselves to think of growing up and hotly resent the thought of growing old. Both seem to be symbols of fading or of loss, Time's stealthy step like some far minute bell tolling us to our doom. Experience does not mean decline nor age senility. Organs are geared to last our time: their functional reserve or regenerative power preserves their integrity throughout life. Acute injuries followed by processes of repair, MacNider has shown, cause fixed cells to change their configuration, to modify their receptivity to injurious agents (7). Thus tissue resistance is acquired. The process of growing old enhances adaptability. Infirmity is the outcome of another process, the weakening of the resistance of these same cells, with senility as its end result if intercurrent afflictions have not destroyed the metabolic power. The organs are the armies, the adventurers, but the somatic tissues are the terrain which bears the scars of battle and the evidence of progress. Some somatic tissues, like the skin and hair and nails, can undergo great changes apparently with little consequent effect on the organism itself. Perhaps the central nervous system falls into this category. The ectoderm may even be misleading. Ento-

*An address presented to the Ohio Academy of Science, May 14, 1937.

dermic integrity is far more vital. But in the mesodermic structures bone and muscle, circulatory and respiratory systems, is betrayed the progress of the aging process which the organs themselves conceal. Of these the skeleton is most readily investigated, thanks to roentgenography. And that is why I ask your attention in a study of the bones, not as zoologists or anatomists, but as biologists intent upon the fundamental principles of life and their expression.

It is in an investigation such as this that one realizes most clearly the futility of sideral time to express in any way the progress of aging. The waxing phase of aging lasts we say some twenty years, a short portion of our whole life span but one during which aging progresses with tremendous speed. The waning phase is said to last from thirty-five years till the close of life, a period long in time but marked by relatively little change, so slowly does the aging process affect the healthy body. Twice previously have efforts been made to measure progress in aging, neither however very simple in execution. Lecomte de Noüy measured the rate of healing in a wound at different ages and found that it follows an exponential curve (6). The tissues of the body and the blood plasma together complete a closed system, changes in the one being reflected in the other. Consequently it has been suggested that the characters of the blood plasma may be used to demonstrate the progress of aging, through its power of retarding the vigor of cellular subdivision in vitro. Young plasma has very little more effect than a nutritive saline solution. Aged plasma will completely inhibit the subdivision (1).

The method which I propose has the advantage of calling for very simple technique, of affording a simple assessment, and of being equally reliable with the other two methods to which allusion has just been made. It also is applicable to all mammals as well as Man and readily enables comparisons of aging to be made in very different forms of mammal. It has the further advantage of registering health as well as maturity. The technique required is the roentgeneography of the limbs to show the stage of development of epiphysial centers if the animal be young; the condition of articular ends and degree of mineralization of the bones if the animal be adult. In human beings and large animals we make roentgenograms of left side only, hand, foot, elbow, knee, shoulder and hip. At certain stages roentgenograms of the vertebral column and perhaps of the sternal

ends of the clavicles are essential. But the vertebral column roentgenogram is no longer helpful after the twentieth birthday for then epiphyses of centra are united (21). And the roentgenogram of the clavicle is useless for a similar reason after the age of twenty-eight (12). Symphysis pubis can, however, be helpful up to thirty-five years (13). If the animal is small it is simplest to make one roentgenographic film of the entire body.

The method merely accomplishes by a quickly and easily applied technique what otherwise can be readily carried out by actual examination of the skeleton (11, 19, 20). It is applicable equally to the living and the dead. It gives us a picture of life in the fourth dimension, namely duration.

One need scarcely remind a biological audience that there are, in the skeleton, primary and secondary centers of ossification, that these appear at certain stages of early life, enlarge, take on the adult contour of the bone and finally merge themselves as integral parts of the skeleton. I purposely speak of primary as well as secondary centers for I do not want to confine our attention to epiphyses but include such skeletal elements as carpals and tarsals, union of primary innominate elements and even sutures.

The initial appearance of these centers and the ultimate incorporation of the bony element into which they develop in the skeleton, or fusion with the shaft if they appear in epiphyses, has been very crudely and unsatisfactorily investigated, usually without any collateral inquiry into the health or living conditions of the children studied. Consequently statistical reductions of age relationships have labelled both ossification and union unreliable as age indicators because of the considerable age range covered by each of these stages. That there is a considerable range in age is perfectly true. The important point is that if unions are systematically studied, it is found that the sequence of union is invariable. This fact I pointed out to Stevenson in 1923 on the basis of researches already carried out while making the collections of human and mammalian skeletons for the Hamann Museum. It was utilized by Stevenson as the theme for his thesis (11). The invariable sequence, despite the range in age relationship of union in each item, throws a very different light on the problem. It means that the entire union pattern is speeded up or retarded in relation to sidereal time. The question naturally arises: Why the individual

variation? Plotting our results on a very large series of observations (18), we find the curve skewed. It has an abrupt forward boundary and a straggling tail. Hence, there is a very definite limit to acceleration but no practical limit at all to retardation. Clearly this is not a feature inherent in the organism but something induced by the environment. Further investigation shows that retardation may be experimentally induced (17) or result from adverse conditions of health, diet or housing (16). As the result of infliction on successive generations the retardation may develop the aspect at least of a hereditary character (2).

Another closely related question occurs to one at this stage, namely, how, if the entire union sequence can swing forward or backward in sidereal time, one can tell without the evidence of the years whether the sequence is retarded or not. When retardation has reached a clinically significant degree, there are definite evidences, pathological or quasi-pathological in nature, which testify to its irregularity (3, 17, 20).

Still another question arises, born this time of the conventional linkage of ossification with union of epiphyses in thought and discussion. The epiphyses which ossify first unite last, it is said. In a sense this is true, but it is one of the half-truths which prove most misleading. Both primary and secondary centers appear in sheaves from which one or more centers may be missing owing to defects in available mineral, Vitamin D or both (4, 23). If a center fails to ossify on time, it may be delayed for a long while and other centers ossify ahead of it. But that has no influence on the age of final union. These two morphological processes, being influenced quite separately by environmental conditions occurring at great intervals of time, could not, except by accident, present a unified relationship to a third phenomenon.

It is extraordinary also that investigators of epiphysial ossification or union rarely thought of studying the bony nodule in the interior (9) until I brought this forcibly to scientific notice (14, 15, 18). At first mineral is laid down as a finely granular dot in the nubbin of cartilage. The granular dot is approximately spherical. Then it begins to grow lopsided and next fashions for itself a contour, extending irregularly until it begins to resemble the periphery of the adult bone or bone-end. The later stages, if it be a separate bone such as a carpal or a tarsal, progress slowly but individuality and vigor of outline is the result with all the characteristic modelling of the finished

bone. If the ossification is that of an epiphysis, there are stages in the face abutting on the shaft, just as characteristic as those of the subarticular contour, but they are not so suited for assessment into a chronological sequence.

The orderly sequence of development in the epiphysial, carpal or tarsal contour can readily be recorded as we have done for the human skeleton (15) and are now describing in more complete detail (18). Thus initial ossification, sequence in fashioning of contour and ultimate union can all be used as indicators of progressive maturation in the skeleton.

But there are pitfalls. The sick child or unhealthy animal will not be easy to assess. Retardation of progress may result in delayed union, though the sequence of union in the approximately fifty skeletal areas of epiphyses to be studied will usually be retarded as a program, not in some haphazard fashion. Under certain conditions, it is true, one or two epiphyses are picked out and retarded while the progress of union in the skeleton as a whole passes them by. Retardation which is often erratic, irregular and asymmetrical in the epiphysis, though not bilaterally asymmetrical, may occur in the phase of expanding bony contour. Deficiency in necessary mineral or catalyst may cause delay in the initial ossification of one or more in a sheaf of centers. All these are special problems for the investigator who is making a tool of the phenomenon of ossification. They have been discussed in considerable detail elsewhere and need not delay us now. It is these features, however, which have given rise to the assumption of natural variation through lack of understanding of the cause of individual difference.

The first use to which we put this special knowledge of the sequence in skeletal maturation was archeological. It was the identification of the age of Akhenaten, the heretic pharaoh of the Eighteenth Dynasty. Our assignment of twenty-two years to this active and restless personality has never been accepted but no one cavilled at the eighteen years assigned to one of his successors, Tutankhamen. We are now at work on the age of the famous Princes in the Tower, Edward V of England and his brother, the Duke of York. There is no doubt that the bones are the bones of these princes but they show evidence of such poor health in the children that both are retarded in progress between one and two years. The story of our disentangling the

mystery of a skeleton in a famous oil litigation has been already described in full (8).

Not only the anthropologist or the medico-legal expert finds an effective tool in skeletal maturation. The zoologist is enabled thereby to judge the comparative age of young skeletons and to assess in terms of maturation the evidence in any skeleton set before him. It is true in other mammals as in children that vagaries may be induced by dietetic deficiencies or health defects. But barring these, the assessment of maturation in any mammalian skeleton is not a difficult task. The assessment provides a ready means of investigating the duration of the several phases of growing up.

The physiologist's problem is this one of differential maturation. Our investigation of living primates, for the sequence can be studied by roentgenography in the living just as well as by dissection of the dead, shows that the phase of infancy and that of the grade school period in the anthropoid are very short whereas the preschool and adolescent phases cover about as much time as those phases of a child's life. It is in the slowing down of progress in different phases of maturation that the primate differs from the non-primate, the anthropoid from the Old World ape and Man from the anthropoid.

There is definite usefulness for this tool in the nutritionist's work. Not only is the sequence of maturation significant in keeping a check upon experimental animals but fluctuations in its progress may be assessed against a standard table or against controls in the investigation of optimum conditions of life and health or the influence upon the animal of specific experimental procedures.

Then there is a clinician's problem which has already been lightly sketched. Disturbances in the maturation program, retardations that is in progress, are signs of handicap far more pronounced than those which result merely in failure of growth. The recovery of a child from one of these more severe handicaps is announced in the restoration of normal progress in the maturation schedule.

There is a farmer's problem to be touched upon here. And this is not by any means the least significant for it is bound up in the larger issue of early and late maturing of stock and the raising of animals for meat. It has been touched upon but not systematically studied by Sanson (10), von Tscherwinsky

(22) and Hammond (5). We have given it considerable attention in our laboratory (17) and find it a fascinating study of very great practical community importance.

Of all the several aspects of the maturation pattern to which I would refer in this brief discussion, however, there is none that equals in its import that of the educator and the parent. Our school system is based on age and it is in terms of age that we evaluate the responsibilities of a child. That is our convention: it may lead us right or it may lead us wrong. The child himself chooses his companions by size without regard to age and this is a surer guide. But he realizes himself in terms of his maturity which is betrayed in his skeletal pattern for the organism, to be in health, must function as a unit. His aspirations, his hopes, his cravings, his human relationships are postulated not on age or experience or stature or weight but on the level he has reached in maturity, which we lightly call, "growing up." It is of little moment that a boy be twelve years old or have the stature of a lad of fourteen. If the level of his maturity be but ten years his thoughts and feelings will be determined by that level. Experiences beyond that will pass ineffectively over his head. If the girl be twelve years old and her stature that of ten, these will have no bearing at all on her capacity for social adjustment should her level in maturity be fifteen. To treat her as a child will be but to outrage her whole being and to evoke in her a resentment and the sullen rebellion in which unremitted misunderstanding inevitably results. When we shall have realized and based our domestic and social relationships upon this more complete knowledge, life will have greater fulness both for our children and for ourselves.

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This is a vivid story of the progress of science through five centuries told by a chronological series of a dozen biographies. The author writes with evident freedom of expression. His description of Calvin's part in the death of Servetus is a vivid picture but one which is not likely to be quoted by present day speakers on the harmonies of science and religion. Many of Gumpert's trail blazers are given more credit than that usually accorded to them in writings on the history of science. Servetus is pronounced the discoverer of the pulmonary circulation, Wolff appears as a pioneer for the doctrine of evolution, Meyer is credited with the original conception of the law of the conservation of energy, and Pettenkofer is pronounced the originator of the periodic system. Every chapter in this book is stimulating. The great volume of our American and English scientific literature serves as a barrier to the translation of many works from foreign languages. It is fortunate that this volume has passed that barrier.—*R. A. Hefner.*

Trail Blazers of Science, by Martin Gumpert. (Translated from the German by Edwin Shuman.) 300 pp. Funk and Wagnalls. $2.50.

THE TRANSFORMATION OF PERCENTAGES FOR USE IN THE ANALYSIS OF VARIANCE

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The unit used most frequently in expressing the results of field experiments in economic entomology is the percentage, such as the percentage mortality, the percentage infestation, etc. Usually these experiments have not been planned so as to include an objective estimate of the experimental error but recently several writers[1] have attempted to correct this deficiency by means of the analysis of variance. Although the analysis of variance probably serves this purpose better than any other method, it was not developed originally for use with percentages and it is desirable to examine this application somewhat more closely.

Two essential features of the analysis of variance are (1) that the plots containing different treatments are exposed equally and at random to the chance of experimental error, and (2) that all contributions to the net experimental error are pooled to give a single estimate of its magnitude, with which the variation due to treatment can be compared. Presumably the portion of this error coming from each plot is independent of the treatment to which it has been exposed, so that all plots contribute equally. However, when the experimental results are in terms of percentages, the error is a function not only of the number of individuals upon which the percentage is based—which often can be equalized experimentally—but also of the theoretical percentage which is sampled by the observed value. If, in fact, all treatments were to produce the same percentage effect within the limits of the sampling error, so that the theoretical percentage could be taken as constant, then the pooled estimate of error would be a valid one and could not lead to incorrect conclusions. But more often the treatments will not be of equal effectiveness and in such cases the results on plots that are given some treatments will be estimated within narrower limits than the results on plots that are given other treatments.

[1]L. L. Huber and J. P. Sleesman, J. Econ. Entom., 28, 70, 1935. T. R. Hansberry and C. H. Richardson, Ia. State Col. J. Science, 10,27, 1935.

Under these circumstances a pooled estimate of error, especially in the study of interactions, may not be a reliable measuring stick. The discrepancy is further increased if a significant amount of field heterogeneity has been eliminated from the estimate of the experimental error by a randomized block or Latin square arrangement.

The information, I_p, in an observed percentage (or proportion) is by definition the reciprocal of its variance and for large samples is given by the equation

$$I_p = \frac{n}{pq},$$

where p is the theoretical or expected proportion of one type of individual, such as of dead insects after a poison spray, $q = 1 - p$ or the theoretical proportion of the alternative type, as of insects surviving the spray, and n is the number of individuals counted in determining a given percentage. The dependence of I_p upon this theoretical proportion is shown in Fig. 1, in which I_p is taken as unity when $p = 0.5$. The information contained in any observation is a minimum at $p = 0.5$ and increases rapidly as the proportion falls below 0.1 or rises above 0.9. Moreover, the theoretical proportion is not known *a priori* but is itself the object of estimation.

The most convenient way of eliminating this variability would be to transform the observed percentages to a unit that is not dependent upon the theoretical proportion but, whatever its value, contains an equal amount of information. Such a procedure would be analogous to the conversion of the correlation coefficient to the statistic z when testing significance or when combining data, as described in Section 35 of "Statistical Methods for Research Workers," by R. A. Fisher. The transformation of percentages to probits,[2] which were introduced for another purpose, would not meet our requirements, since the information on the probit scale is also dependent upon the expected proportion, although it has a maximum instead of a minimum at $p = 0.5$ (Fig. 1).

Prof. R. A. Fisher has written me that the problem can be resolved by transforming each percentage to an angle θ such that $p = \sin^2\theta$. As the proportion p varies from 0 to 1 or the observed percentage from 0 to 100, θ will change from 0° to 90°.

[2]C. I. Bliss, Ann. Appl. Biol. **22**, 134. 1935.

Then

$$q = \cos^2 \theta,$$

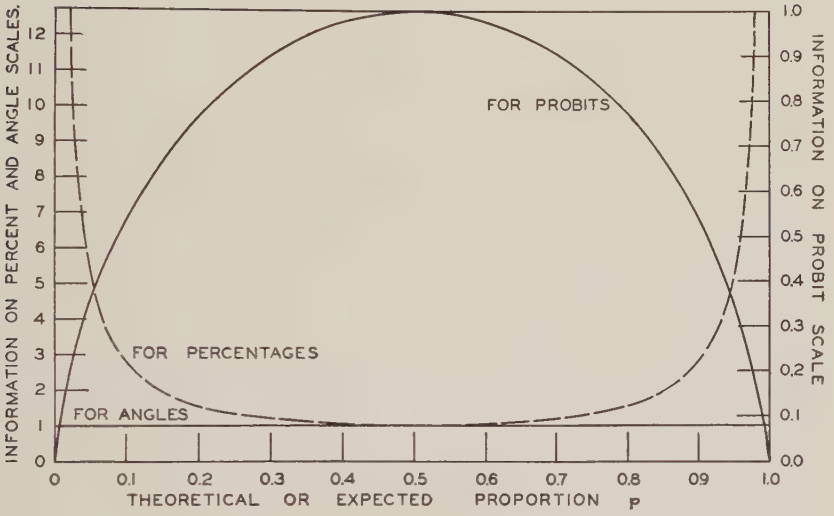
$$I_p = \frac{n}{pq} = \frac{n}{\sin^2 \theta \cos^2 \theta},$$

and

$$I_\theta = I_p\left(\frac{dp}{d\theta}\right)^2 = \frac{n}{\sin^2 \theta \cos^2 \theta} \cdot 4 \sin^2 \theta \cos^2 \theta = 4n,$$

since

$$\frac{dp}{d\theta} = 2 \sin \theta \cos \theta.$$


INFORMATION ON PERCENT AND ANGLE SCALES.
INFORMATION ON PROBIT SCALE
FOR PROBITS
FOR PERCENTAGES
FOR ANGLES
THEORETICAL OR EXPECTED PROPORTION p
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
0 1 2 3 4 5 6 7 8 9 10 11 12
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

The value for I_θ is exact and is independent of p or θ, as indicated by the horizontal line in Fig. 1. For large samples the distribution tends to normality and consequently has the limiting variance formula $V(\theta) = \frac{1}{4}n$. In most field experiments the percentages are based upon relatively large numbers, of 100 or more individuals, so that usually the transformation would accomplish its purpose. For small samples the distribution is not normal and the effect that this may have upon the variance of the angle when $n = 10$ (which may be taken as a minimum) has been discussed in a recent paper by M. S. Bartlett.[3] His study shows that at this lower limit the variance is still a function of p, but not more so than is the original percentage.

[3] M. S. Bartlett, J. Roy. Stat. Soc. Supplement **3**, 68. 1936.

Although the gain would be less, the use of this transformation for samples of only moderate size should not introduce any new errors in the subsequent analysis of variance.

The usefulness of the transformation from percentages to equivalent angles depends upon the availability of tables by which the one can be converted directly into the other. It is essential for later computation in the analysis of variance that the fractions of these equivalent angles be expressed in a

TABLE I

ANGLES OF EQUAL INFORMATION ARE GIVEN IN THE BODY OF THE TABLE CORRESPONDING TO OBSERVED PERCENTAGES ALONG THE LEFT MARGIN AND TOP

	0	1	2	3	4	5	6	7	8	9
0	0	5.7	8.1	10.0	11.5	12.9	14.2	15.3	16.4	17.5
10	18.4	19.4	20.3	21.1	22.0	22.8	23.6	24.4	25.1	25.8
20	26.6	27.3	28.0	28.7	29.3	30.0	30.7	31.3	31.9	32.6
30	33.2	33.8	34.4	35.1	35.7	36.3	36.9	37.5	38.1	38.6
40	39.2	39.8	40.4	41.0	41.6	42.1	42.7	43.3	43.9	44.4
50	45.0	45.6	46.1	46.7	47.3	47.9	48.4	49.0	49.6	50.2
60	50.8	51.4	51.9	52.5	53.1	53.7	54.3	54.9	55.6	56.2
70	56.8	57.4	58.1	58.7	59.3	60.0	60.7	61.3	62.0	62.7
80	63.4	64.2	64.9	65.6	66.4	67.2	68.0	68.9	69.7	70.6
90	71.6	72.5	73.6	74.7	75.8	77.1	78.5	80.0	81.9	84.3
100	90.0									

decimal system rather than in minutes and seconds. Such a table has been computed. It will be published elsewhere in full[4] but is given here in abbreviated form. With this aid it should be possible to apply the analysis of variance without error to such field experimental data as can be expressed legitimately in percentages, even when these cover a wide range of values.

[4]C. I. Bliss, Plant Protection, No. 12. 1937. Leningrad.

Allergies

Like the farmer who enjoyed good health until he read the patent medicine almanac, the allergy susceptible person will recall his ailments as he reads this realistic treatise on allergic diseases. In brief compass are outlined causes, symptoms, diagnoses, and treatments. The list of allergy causing agents is astounding to one who has not investigated this group of diseases. Among plants the allergens read like a floral list for a typical midwestern habitat, and the animal list might be headed, "Common animals I have met." The geneticist will be impressed by the statement that more than 50 per cent of the asthma cases have an hereditary history, but detailed family histories are not included. This volume will be of interest to the biologist, the medical practitioner, and the allergic patient.

—*R. A. Hefner.*

Allergy, its Practical Application, by J. A. Rudolph, M. D. 208 pp. Dorrence, 1937. $3.00.

THE BIOLOGY OF CORYTHUCHA AESCULI O. & D. (HEMIPTERA, TINGITIDAE) ON THE YELLOW BUCKEYE, AESCULUS OCTANDRA MARSH[1]

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INTRODUCTION AND ACKNOWLEDGMENTS

In May, 1932, the author noticed that the leaves of the yellow buckeye, *Aesculus octandra* Marsh., were literally covered by the tingitid, *Corythucha aesculi* O. & D., and showed considerable injury due to the feeding activities of this insect. Considerable numbers of various species of lady beetles were also present feeding upon the eggs and nymphs of the tingitid. With the assistance of four undergraduate students in entomology, a study of this association of insects has been carried on from the spring of 1932 until the end of June, 1936. Mr. John H. Hughes aided in the field work in 1932 and drew the figures of the life history of *C. aesculi*. Mr. Harry Bauman aided in the observations in 1933 and the spring of 1934; Mr. Dwight McKeown helped in the fall of 1934 and in 1935; and Mr. Harold S. McGinnis aided in 1936. The author has made observations and directed the study throughout. Acknowledgments are due Dr. C. J. Drake, of Iowa State College, for checking the identification of *C. aesculi* O. & D. and to Dr. Herbert Osborn, of Ohio State University, for determination of the leaf-hoppers mentioned in the paper.

THE LIFE HISTORY OF *Corythucha aesculi* O. & D.

C. aesculi O. & D. hibernates in the adult stage. It has been found under the bark of oak, hickory, and yellow buckeye, at a considerable distance above the ground. It has not been found on the lower part of tree trunks, stumps, logs, under debris or leaves, or in crevices. The number of this species found in hibernation is not a true indication of the number that appears on the leaves of buckeye in the spring, so there is probably still an undiscovered niche for hibernation in which large numbers spend the winter.

[1]Paper No. 13 from the Department of Zoology, Ohio University, Athens, Ohio.

The yellow buckeye is among the first of the forest trees of southeastern Ohio to acquire foliage in the spring and usually its leaves are quite well-developed before the leaf buds of most other trees open. Thus it becomes a concentration point for insects as they come out of hibernation. The adults of *C. aesculi* assemble on the buds of the yellow buckeye as soon as they begin to open. Often the opening buds will be literally covered by the tingitids before the leaves have a chance to spread. Feeding begins immediately and goes on continuously to the end of the season.

TABLE I

Sex Ratio of *C. aesculi* O. & D.

Date	Total Specimens Examined	Males	Females	Sex Ratio
April 26, '33	466	99	367	.79—
" 27, '33	435	95	340	.78+
" 29, '33	450	120	330	.70+
May 1, '33	414	94	320	.78—
" 3, '33	463	103	360	.78—
" 16, '33	85	14	71	.84+
June 10, '33	250	68	182	.73—
May 20, '35	200	61	139	.70—
June 15, '35	425	112	313	.71+
July 22, '35	346	81	265	.77—
June 26, '36	328	78	250	.76+
Totals	3,862	925	2,937	.76+

Females of *C. aesculi* greatly outnumber the males as is shown in Table I compiled from samples swept from the trees on various dates. The sex ratio is approximately .76. In cage experiments one male will mate with several females, and one female will mate with several males. This probably occurs in nature also.

When the weather is warm copulation is in progress in the field within two days after the emergence from hibernation and continues for several weeks. Oviposition commences about two days after copulation and continues about three weeks. The eggs are partially inserted in the tissues of the under side of the leaves along the principal veins. (Fig. 1). The numbers of eggs deposited per leaflet may be enormous. Counts of the eggs on 200 leaflets during the peak of the oviposition period gave an

average of 322 eggs per leaflet (one leaflet of the five of a leaf). Table II summarizes the results of these counts.

Five females in cages deposited an average of 178 eggs each over a period of ten days. The maximum number was 297, the minimum was 64. We have no record of the number laid per

Figure 1. Leaflet of yellow buckeye, *Aesculus octandra* Marsh., showing the position of eggs of *C. aesculi* O. & D.

female in the field, but judging from the number of eggs on the leaflets, it is quite large.

The eggs hatch in from six to twelve days dependent upon the weather conditions and the young of each brood begin feeding in colonies on the under surface of the leaves. Sometimes three or four such aggregations will be found on a single

TABLE II

THE NUMBER OF EGGS OF *C. aesculi* O. & D. PER LEAFLET OF YELLOW BUCKEYE

DATE	NUMBER OF LEAFLETS EXAMINED	NUMBER OF EGGS PER LEAFLET
May 1, '33	10	186
May 2, '34	40	278
May 15, '36	150	342
Total	200	Average 322

leaf. The individuals of each aggregation are of the same instar although different aggregations may be in different instars. These aggregations of the same age remain together until they metamorphose into the adult stage. One may often find the exuviae of all instars of the group attached to the same leaf.

The number of individuals feeding on one leaf varies a great deal but may reach relatively large figures at times. Table III summarizes the counts of tingitids feeding upon the leaves of the buckeye at various times.

The length of time spent in the different instars varies with the weather conditions. High temperatures accelerate development, as is to be expected; low temperatures retard it. Warm dry weather is most favorable to the rapid and complete development of the broods. The spring months of 1932, '33, and '34, were warmer than those of 1935 and '36 in this area. Table IV

TABLE III

THE NUMBERS OF ADULTS AND NYMPHS OF *C. aesculi* O. & D. FEEDING PER LEAF (FIVE LEAFLETS) OF YELLOW BUCKEYE AT VARIOUS TIMES

(Each figure is the average of the counts on 100 leaves chosen at random.)

DATE	ADULTS	NYMPHS	TOTALS
May 7, '32	41	0	41
" 23, '32	28	136	164
June 27, '32	7	158	165
May 18, '33	36	140	176
" 31, '33	12	61	73
June 3, '34	27	96	123
May 19, '35	17	0	17
July 6, '35	4	48	52
June 26, '36	129	13	142

shows the effect of this difference distinctly upon the development of the tingitids. Heavy rains accompanied by strong winds frequently wash and blow large numbers of nymphs from the trees and thus reduce the populations materially. On May 25, 1933, for example, 2.77 inches of rain fell in the area within a few hours. Table III shows a population of 176 per leaf on May 18 and of 73 per leaf on May 31. A number of such instances when smaller numbers of leaves were counted appear in our records.

The total time from the deposition of eggs till the adult stage is reached is between six and seven weeks for the spring brood and slightly less for the summer brood. Table IV gives the dates of emergence from hibernation, the periods of copulation and oviposition, and the periods during which various instars were present in the field for both the spring and summer

broods. The dates are the first and last days on which the various stages were observed in the field. Since at times one or two days elapsed between observations, the actual appearance

TABLE IV

SEASONAL HISTORY OF *C. aesculi* O. & D. THE DATES REPRESENT THE FIRST AND LAST DAYS OF EACH YEAR UPON WHICH STAGES WERE OBSERVED IN THE FIELD

Year	Date of Emergence from Hibernation	Period of Copulation	Period of Oviposition	1st. Instar Present	2nd. Instar Present	3rd. Instar Present	4th. Instar Present	5th. Instar Present	Adult Present	Brood
1932	?	? to May 7	? to May 10	? to May 16	May 8 — May 23	May 14 — May 31	May 21 — June 6	May 26 — June 12	June 2 — July 5	SPRING
1933	Apr. 17	Apr. 18 — May 2	Apr. 20 — May 6	Apr. 26 — May 14	May 3 — May 22	May 9 — May 29	May 16 — June 8	May 22 — June 15	May 28 — July 8	
1934	Apr. 18	Apr. 20 — May 5	Apr. 21 — May 7	Apr. 30 — May 15	May 7 — May 23	May 13 — May 31	May 20 — June 6	May 28 — June 13	June 6 — July 6	
1935	Apr. 29	May 1 — May 20	May 4 — May 27	May 15 — June 4	May 24 — June 11	June 2 — June 26	June 11 — July 4	June 19 — July 11	June 26 — July 22	
1936	Apr. 23	Apr. 25 — May 16	Apr. 29 — May 24	May 12 — June 3	May 19 — June 11	May 27 — June 16	June 3 — June 21	June 10 — June 28	June 17 — ?	
1932		June 3 — June 11	June 4 — June 14	June 9 — June 20	June 14 — June 25	June 20 — July 2	June 28 — July 10	July 5 — July 18	July 12 — Sept. 17	SUMMER
1933		May 29 — June 10	May 31 — June 12	June 7 — June 19	June 13 — June 27	June 20 — July 5	June 27 — July 12	July 6 — July 20	July 13 — Sept. 23	
1934		June 8 — June 19	June 9 — June 22	June 16 — June 30	June 23 — July 8	June 30 — July 15	July 6 — July 23	July 12 — Aug. 1	July 17 — Oct. 2	
1935		June 27 — July 6	June 28 — July 9	July 5 — July 15	July 10 — July 23	July 16 — July 31	July 22 — ?	July 27 — ?	Aug. 3 — Sept. 25	
1936		June 19 — ?	June 20 — ?	June 26 — ?	Observations discontinued					

or disappearance of the stage may in a few cases be a day or two earlier or later than given. However, observations for the five years check rather closely with each other and it is believed

that the record as a whole is quite accurate. Figure 2 shows the life cycle diagrammatically for the year 1933.

Figure 2. The stages of *C. aesculi* O. & D. present in the field at various times during a typical season. Based on the records of the year 1933. *Spring and summer brood possibly overlap at this time.

Table V gives the average duration of the various instars and Table VI gives their average length in millimeters. Figure 3 shows the egg, the five nymphal instars, and the adult of *C. aesculi*. These figures were all drawn to scale under a compound microscope by Mr. John Hughes. These tables and figures are self-explanatory and need no further discussion.

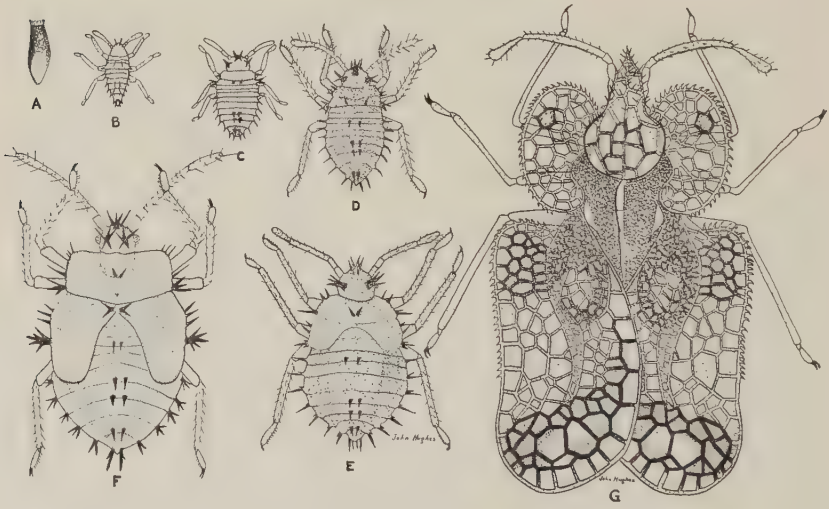

Figure 3. Various stages in the development of *C. aesculi* O. & D. A, egg; B, 1st instar; C, 2nd instar; D, 3rd instar; E, 4th instar; F, 5th instar; G, adult. All stages are drawn to the same scale.

The spring brood develops in much greater numbers than the summer brood for several reasons. The food supply as a rule is much more abundant and succulent in the spring, whereas the summer brood appears at a time when the spring brood has already inflicted heavy injury upon the preferred

portions of the food plant. Many leaves become dry and drop from the trees carrying with them eggs and young nymphs of the summer brood. These usually do not get back to the host plants. Predators are also more abundant when the second brood appears and take a greater toll from it.

TABLE V

DURATION OF THE VARIOUS INSTARS IN THE DEVELOPMENT OF *C. aesculi* O. & D. IN DAYS; BASED ON FIVE-YEAR RECORDS

STAGE IN DEVELOPMENT			EGG	NYMPHAL INSTARS					ADULT
				1st.	2nd.	3rd.	4th.	5th.	
Length in Days	Spring Brood	Range.....	6–13	7–9	5–15	7–9	5–8*	6–9	26–42†
		Mean.....	8.8	7.6	7.7	7.7	6.8*	7.2	35†
	Summer Brood	Range.....	5–7	5–8	6–8	6–8	5–8	5–7	Overwinters
		Mean.....	6.8	6.5	7.0	7.1	7.1	6.3	

*The 4th instar of the spring brood is of shorter duration than any of the other instars of the brood. This does not hold for the summer brood.

†It may be that some individuals of the spring brood survive somewhat longer, for after the summer brood matures it is impossible to separate individuals of the two broods.

TABLE VI

MEASUREMENTS OF THE VARIOUS STAGES IN THE DEVELOPMENT OF *C. aesculi* O. & D. EACH FIGURE REPRESENTS THE AVERAGE OF TWENTY-FIVE INDIVIDUALS

STAGE	LENGTH IN MILLIMETERS
Egg	0.475–0.481
1st. instar nymph	0.64 –0.8
2nd. " "	0.88 –1.04
3rd. " "	1.2 –1.41
4th. " "	1.6 –1.84
5th. " "	2.24 –2.48
Adult	4.0 –4.4

Adults of the summer brood usually appear about the middle of July and remain in the environment in varying numbers until September or October when they go into hibernation upon the advent of cold weather.

EFFECTS ON THE HOST PLANT

The overwintering adult tingitids begin to feed upon the leaf buds of the yellow buckeye before they have a chance to open in the spring. Before long feeding scars become apparent on the under surface of the leaves. The bases of the eggs are inserted along the principal veins and a large number of scars result from this habit of oviposition. Fecal material is also deposited on the under surface of the leaves in the form of multitudinous flecks which block large numbers of the stomata. When the eggs hatch, the nymphs feed in aggregations on the under surface of the leaves and soon the entire areas where they are feeding turn yellowish and finally brown.

The spring brood feeds mainly on young trees and on the lower branches of older trees. Very few individuals are seen at

TABLE VII

MEASUREMENT OF GROWTH OF TWENTY YOUNG TREES, *Aesculus octandra* Marsh.

MEAN HEIGHT		MEAN CIRCUMFERENCE OF TRUNK TWO FEET ABOVE GROUND	
May 7, 1932	June 17, 1936	May 7, 1932	June 17, 1936
6 ft. 8 in.	7 ft. 5 in.	2.5 in.	2.7 in.

heights greater than twenty feet above the ground. By July 1 most of the leaves of the young trees and on the lower branches of older trees are turned brown and begin to fall off. By the middle of July many of the young trees are nearly bare. Many of the eggs of the spring brood deposited in these leaves perish when they hatch, for the nymphs usually do not again reach a food plant. The second or summer brood develops largely from eggs deposited on leaves higher on the older trees and from the few leaves that survive injury by the spring brood and remain on the younger trees.

The injury to the trees is evidently not severe enough to kill but it is probably sufficient to retard growth of the trees. Table VII gives measurements on the growth of twenty young trees in the areas studied.

THE RELATION OF *C. aesculi* TO OTHER INSECTS ON BUCKEYE

Both predators and competitors of *C. aesculi* O. & D. are present. The predators are more important and consist largely of beetles. Table VIII lists the predators, their comparative

TABLE VIII

THE PREDATORS OF *C. aesculi* O. & D. OBSERVED IN THE FIELD AND THE STAGES ATTACKED BY EACH

Abundance is rated as follows: (A) abundant, 1 or more per leaf; (C) common, 1 or more per 10 leaves; (F) frequent, 5 or more observed per trip; (S) scarce, less than 5 individuals seen per trip; (R) rare, less than 5 individuals seen altogether.

FAMILY AND SPECIES	ABUNDANCE	STAGES OF *C. aesculi* ATTACKED IN FIELD
LAMPHYRIDAE:		
Lucidota atra (Fabr.)	F	Nymph 1
Photinus pyralis (L.)	F	Nymph 2
" *scintillans* (Say)	R	Not observed feeding
Photuris pennsylvanica (DeG.)	F	Nymph 1, 2, 3
CANTHARIDAE:		
Chauliognathus marginatus Fab	F	Not observed feeding
Podabrus tricostatus (Say)	R	Nymph 1
" *basillaris* (Say)	F	Nymph 1, 2
" *modestus* (Say)	S	Not observed feeding
CLERIDAE:		
Enoclerus quadriguttatus Oliv	R	Nymph 1
COCCINELLIDAE:		
Hyperaspis binotata (Say)	F	Egg, Nymph 1, 2, 3, 4
Brachyacantha ursina (Fab.)	S	Not observed feeding
" *quadripunctata* (Melsh.)	S	Egg
Microweisea misella (Lec.)	S	Egg, Nymph 1
Stethorus punctum (Lec.)	S	Egg
Scymnus fraternus Lec	A	Egg, 1, 2, 3, 4, 5
" *rubricauda* Csy	C	Egg, 1, 2
" *collaris* Melsh	F	Egg
" *puncticollis* Lec	S	Egg
" *punctatus* Melsh	R	Egg
" *flavifrons* Melsh	S	Egg, 1
Delphastus pusillus (Lec.)	A	Egg
Psyllobora 20-maculata (Say)	A	Egg
Ceratomegilla fuscilabris (Muls.)	F	Egg, 1, 2, 3, 4, 5, Adult
Hippodamia convergens Guer	F	Egg, 1, 2, 3
Neoharmonia venusta (Melsh.)	R	Egg
Coccinella 9-notata Hbst	F	Nymph 1
Cycloneda munda (Say)	F	Nymph 1, 2, 3
Adalia bipunctata (L.)	F	Egg, 1, 2, 3, 4
Chilocorus bivulnerus Muls	S	Egg
ORTHOPERIDAE:		
Orthoperus glaber Lec	C	Faeces, Egg
CHRYSOPIDAE:		
Larvae, sp. not determined	C	Nymphs 1, 2, 3, 4, 5
HEMEROBIIDAE:		
Larvae, sp. undetermined	C	Nymphs 1, 2
PENTATOMIDAE:		
Brochymena arborea (Say)	S	Nymph 5, Adult
ANTHOCORIDAE:		
Lyctocoris stalii (Reuter)	S	Egg, Nymph 1
Xylocoris cursitans (Fallen)	F	Egg
MIRIDAE:		
Camptobrochus nebulosus Uhler	F	Egg, Nymph 1, 2
ARACHNIDA:		
Synemosyna formica Hentz	F	Egg, Nymph 1, 2, 3
Dictyna foliacea (Hentz)	F	Nymph 1, 2
Two other spiders undetermined	R	Nymph 1, 2

abundance, and the stages of *C. aesculi* attacked by them. Some species of beetles that are known to be predacious on other insects although not observed feeding on *C. aesculi*, were present on the trees and are listed in the table for it is very likely that most of them do feed on the tingitids.

Of the forms studied the lady beetles form by far the most important group of predators upon *C. aesculi*, and among them *Scymnus fraternus*, *Scymnus rubricauda*, *Delphastus pusillus*, *Psyllobora 20-maculata*, and *Adalia bipunctata* are the most effective. The predators destroy large numbers of young of *C. aesculi* in all stages from the egg to the fourth instar and smaller numbers of the older stages. The toll taken from the summer brood is greater in proportion than that taken from the

TABLE IX

EGGS OF *C. aesculi* O. & D. DEVOURED BY PREDATORS IN CAPTIVITY IN FOUR, FIVE, OR SIX DAYS

PREDATORS	NUMBER OF INDIVIDUALS	TOTAL EGGS CONSUMED	EGGS CONSUMED PER DAY
Scymnus fraternus Lec.	4	292	14.6
Scymnus rubricauda Csy.	8	500	12.5
Delphastus pusillus (Lec.)	10	470	8.7
Ceratomegilla fuscilabris (Muls.)	3	350	25.
Psyllobora 20-maculata (Say)	15	1407	17.8
Adalia bipunctata (L.)	7	851	23.

spring brood. The numbers destroyed are not sufficient, however, to keep the tingitid from becoming exceedingly abundant as has been shown in the preceding sections of this paper.

A few experiments were carried out to determine the number of tingitid eggs destroyed by some of the lady beetle predators. Table IX gives the results of these.

Various parasitic Hymenoptera were observed on the foliage frequently but no oviposition was noted and no parasites were reared from any of the eggs or nymphs that were caged.

There are certain insects that attack the buckeye leaves and thus serve as competitors of *C. aesculi*. Some of these became fairly abundant at times, but at no time was their influence

great enough to bring about a shortage of food for the tingitids. Table X gives a list of those observed feeding on buckeye leaves.

Another tingitid, *Gargaphia tiliae* Walsh, sometimes occurs abundantly on the yellow buckeye during the mating season. It has never been observed to feed upon the leaves. Many other species of insects were observed on the foliage occasionally but since they were few in numbers and no feeding activity was observed, they are omitted from this discussion.

TABLE X

INSECTS FOUND FEEDING ON THE LEAVES OF THE YELLOW BUCKEYE, *Aesculus octandra* MARSH., IN COMPETITION WITH *C. aesculi* O. & D.

FAMILY AND SPECIES	ABUNDANCE
HOMOPTERA:	
Cicadellidae.	
Graphocephala versuta (Say)	F
Erythroneura vulnerata (Fitch)	A
Erythroneura basilaris (Say)	F
LEPIDOPTERA:	
Geometridae.	
Larvae, sp. undetermined	F
COLEOPTERA:	
Scarabaeidae.	
Dichelonyx subvittata Lec	R
Chrysomelidae.	
Syneta ferruginea (Germ.)	S
Nodonota puncticollis (Say)	S
Paria canella (Fab.) and var	C
Diabrotica 12-punctata (Fab.)	F
Diabrotica vittata (Fab.)	F
Luperodes cyanellus Lec	S
Crepidodera erythropus Melsh	A
Epitrix fuscula Cr	S
Epitrix cucumeris Har.	C
Chaetocnema minuta Melsh	C
Baliosus ruber (Web.)	R
Chiridia guttata (Oliv.)	F
Metriona bicolor (Fab.)	F
Mylabridae.	
Mylabris mimus (Say)	C
Curculionidae.	
Two sp. undetermined	F

SUMMARY

1. The life history of *Corythucha aesculi* O. & D. on yellow buckeye, *Aesculus octandra* Marsh., has been studied for five years and the data summarized for each stage of development.

2. The sex ratio of *C. aesculi* is approximately .76.

3. The spring brood confines its attack largely to young trees and the lower branches of older trees.

4. The summer brood develops mainly in older trees twenty or more feet above the ground.

5. Many eggs and young of the summer brood never develop because the leaves on which the eggs are laid drop from the trees and the young do not get back to their food plant.

6. Forty predators, mainly insects, were found on the buckeye trees. Most of these were observed to attack one or more stages of *C. aesculi* and thus reduce the populations of both broods. They are not effective enough to control the tingitid.

7. Six species of lady beetles have been fed upon the eggs of *C. aesculi* while in captivity.

8. Twenty-one insects have been observed feeding upon the leaves of the yellow buckeye in competition with *C. aesculi*. None of them were ever abundant enough to cause a shortage of food for the tingitid.

9. Injury to leaves of young buckeye trees causes them to drop their leaves in midsummer. This results in slow growth of the trees. Older trees seemingly suffer little injury since only the lower leaves are severely injured.

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Physical Optics

Fundamentals of Physical Optics by Jenkins and White seems to the reviewer to be an excellent text for advanced undergraduates and graduate students in their early career. The contents are divided into nineteen chapters and each chapter is divided into paragraphs so numbered that reference to them is most convenient. The subject matter is illustrated very amply throughout by lucid diagrams and excellent photographs. Especially commendable are the many photographs of spectra, diffraction patterns, interference patterns and the Faraday effect. Very desirable is the long list of examples found at the end of each chapter, a feature which makes this work very useful in courses of physical optics. The material is clearly presented and is printed in clear readable type and the book may sincerely be recommended to teachers of physical optics and is a convenient reference book on the shelf of the man actively engaged in research.—*H. H. Nielsen.*

Fundamentals of Physical Optics, by F. A. Jenkins and H. E. White. xiv+453 pp. New York, The McGraw-Hill Book Co., 1937. $5.00.

RECENT EARTHQUAKES IN WESTERN OHIO[1]

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INTRODUCTION

On March 2 (9:48 A. M.) and again on March 9 (12:45 A. M.), 1937, western Ohio and surrounding states were shaken by earthquakes of such strength as to be generally felt throughout Ohio and detected in the adjacent states of Kentucky, Indiana, Michigan, western Pennsylvania, and West Virginia. Seismographs at Xavier University at Cincinnati and John Carroll University at Cleveland recorded shocks, lasting from 2 to 3 minutes, on both of these dates.

The purpose of this paper is to describe the method employed to locate the epicenter by a non-instrument type of study and to briefly outline the pertinent geologic conditions in the vicinity of the epicenter. After each earthquake a survey of western Ohio was made dealing with the intensities of the shocks in the different regions as revealed by disturbances of objects on the earth's surface. These disturbances were in the form of property damage, movement of objects in buildings, displacement of monuments in cemeteries, and numerous other miscellaneous phenomena. Careful analysis of the displacement of objects showed that the direction of movement of the earthquake waves at specific points could be determined. Since the two earthquakes had a common epicenter and differed only in intensity, they generally will be discussed together throughout this paper.

INTENSITY OF THE EARTHQUAKES

Brief mention should be made regarding the intensities of the earthquakes before discussing the epicenter of these quakes. Since the epicenter is that surface area where the earthquake waves are felt first and where the property damage is the great-

[1]The writers wish to thank Professor J. Ernest Carman, who suggested the problem, for helpful suggestions regarding the preparation of the manuscript, and Rev. V. C. Stechschulte for profitable discussions concerning the Ohio earthquakes. We also gratefully acknowledge the helpful co-operation of Mr. George Rilling, Superintendent of Anna public schools, and other residents of the earthquake area.

est it naturally follows that a study of the relative damaging effects of an earthquake will help to delimit the epicenter. In order to have a uniform method of evaluating earthquake intensities seismologists have established certain intensity scales in which varying degrees of property damage and human reactions are grouped under specific intensity numbers. The Rossi-Forel scale, given below, is one such scale.

ROSSI-FOREL SCALE

I. *Microseismic shock*: Recorded by a single seismograph or by seismographs of the same model, but not by several seismographs of different kinds; the shock felt by an experienced observer.

II. *Extremely feeble shock*: Recorded by several seismographs of different kinds; felt by a small number of persons at rest.

III. *Very feeble shock*: Felt by several persons at rest; strong enough for the direction or duration to be appreciable.

IV. *Feeble shock*: Felt by persons in motion; disturbance of movable objects, doors, windows; cracking of ceiling.

V. *Shock of moderate intensity*: Felt generally by everyone; disturbance of furniture, beds, etc., ringing of bells.

VI. *Fairly strong shock*: General awakening of those asleep; general ringing of bells; oscillation of chandeliers; stopping of clocks; visible agitation of trees and shrubs; some startled persons leave their dwellings.

VII. *Strong shock*: Overthrow of movable objects, fall of plaster; ringing of church bells; general panic, without damage to buildings.

VIII. *Very strong shock*: Fall of chimneys, cracks in the walls of buildings.

IX. *Extremely strong shock*: Partial or total destruction of some buildings.

X. *Shock of extreme intensity*: Great disaster, ruins, disturbances of the strata, fissures in the ground, rock-falls from mountains.

The particular value of such a scale is that it enables one to submit questionnaires to residents in different parts of the affected areas and on the basis of their answers plot isoseismic maps showing the intensities of the earthquake in specific regions. The intensity will be greatest, that is highest number, in the vicinity of the epicenter and will decrease outward from this area. Such a map was drawn for the earthquakes in western Ohio and is shown in Figure 1.

The second earthquake, March 9, was of much greater intensity than the first one of March 2. This statement is readily apparent to those who experienced both shocks and is further verified by the greater property damage caused by, and

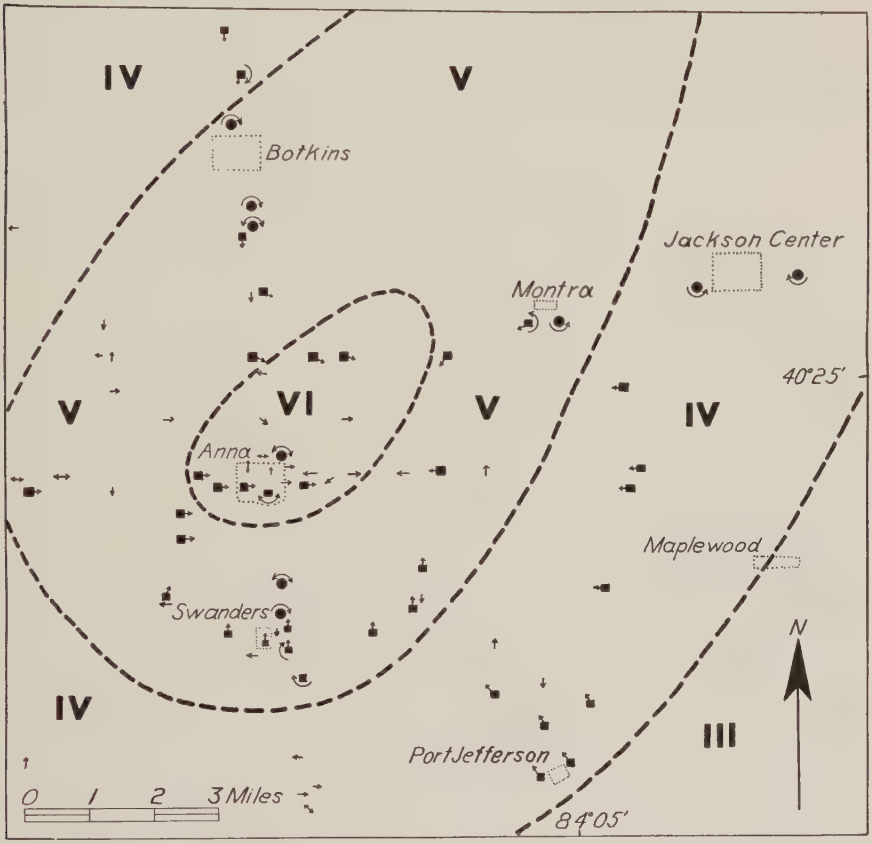

Figure 1. Isoseismic map of the epicenter and vicinity for the earthquake of March, 9, 1937. Roman numerals refer to Rossi-Forel Scale intensity numbers, the area marked VI being the epicenter. Arrows indicate direction of movement of non-fixed objects in buildings. Black squares represent chimneys, the attached arrows showing the direction they fell or the direction they leaned after the earthquake. Black circles, cemeteries, the arrows showing the direction of rotation of sectional monuments; if an arrow is present on both ends of the line it indicates that some monuments rotated clockwise, others counter clockwise. (Base map from the Sidney quadrangle.)

the seismic records of the later earthquake. A field study of the first earthquake was made before the second one occurred and after studying the second one excellent material was at hand for comparing the intensities of the two. Such a com-

parison showed greater property damage, greater rotation of heavy monuments in cemeteries, and more displaced objects after the second quake. In one of the grocery stores in the village of Anna some 300 items were shaken from the shelves by the first earthquake while the second one caused some 1300 items to fall to the floor.

At the epicenter, the earthquake of March 2 had an intensity of IV+ and the one of March 9, VI+ as measured by the Rossi-Forel Scale.

LOCATION OF EPICENTER

Various lines of evidence have been used for recording data concerning earthquakes when recording instruments are not available. These criteria are well summarized in Heck's book on "Earthquakes."[2] He points out that a study of the movement of objects on the earth, damage to buildings, feelings experienced by individuals, etc., must be used if the epicenter is to be delimited as occupying a certain definite area in a region. Two types of evidence were found most useful in this study in western Ohio: (1) the movement of relatively free objects as indicating the direction of wave motion; (2) the damage done to buildings, etc. It was found that the directions of movements of objects were remarkably constant for any locality and when these directions were plotted on a map (Fig. 1) they were found to radiate from a central area. Since earthquake waves reach the epicenter first and are later felt in areas surrounding the epicenter the directions of movements should radiate from the epicenter. Similarly it was found that the damaging effects were greater in the area from which these directional movements radiated.

With the foregoing in mind, some examples of movements and property damage may be examined in detail.

INTENSE DISTURBANCES

The property damage in the village of Anna, Ohio, located in northern Shelby County, was greater than in any other town affected by the earthquakes. Here the three-story brick schoolhouse was so badly damaged that building inspectors condemned it and present plans call for the construction of a new story-and-a-half earthquake-proof structure. None of the walls of the structure fell but the brick walls were severely cracked

[2]N. H. Heck: Earthquakes. Princeton University Press (1936), pp. 52–64.

and showed pronounced bulging after the quake (Plate 1). This damage was present on all walls of the schoolhouse but the northeastern corner showed greater displacement and opening of cracks than any other portion. In the same village the brick Methodist Church and one brick residence were irreparably damaged, while the belfry of the Lutheran Church was shaken down and a large interior masonry arch has been removed and replaced by one of steel construction. Practically all of the brick chimneys in Anna were damaged, being either overthrown or rotated clockwise or counter clockwise at high angles. The upper 10 feet of the 3 foot square brick chimney on top of the Anna school moved eastward 3–4 inches and rotated clockwise. The few chimneys remaining upright in Anna usually lean to the north or east. Many foundations were cracked, the filling in old wells settled, and cistern walls cracked. Within a radius of 5 miles of Anna approximately three-fourths of the chimneys required repair. In this zone of intense disturbance the cost of repairing and replacing all damaged property has been estimated to be as high as $300,000.

The movement of objects in buildings and monuments in cemeteries was more pronounced in Anna and the immediate vicinity than elsewhere. In the following discussions it should be remembered that when an object in a building is displaced it does not mean that it will be displaced in the direction the earthquake wave is moving, but rather in the direction from which the wave came. Thus if an object is said to move east with reference to the support on which it rests it means that the earth tremor moved the support west. If a coin is placed on a book and the book is struck at one end the coin will move towards that end which received the impact.

In one of the groceries in Anna a large counter ($20' \times 3' \times 2'$) and a stove weighing 600 pounds moved westward 1—2 inches and heavy laboratory tables as well as filled bookcases in the Anna school moved from 2 to 4 inches in the same direction. Stoves, refrigerators, and bookcases moved east in some houses, north in others, and south in a few residences. Heavy stone steps in front of the Lutheran Church moved 3 inches to the north.

All objects did not move in the same direction in Anna. Lighter objects, as well as heavy ones, show diversified movements. In the Anna public school each room had a radio loud speaker resting on a small shelf above the blackboards. These

speakers were all moved by the earthquakes, tracing their movement in the dust on the shelves. This movement varied between ¼ and 1 inch, with north and south movements predominating over northwest and southeast movements. In the

TABLE I

ROTATIONAL MOVEMENTS OF MONUMENTS IN CEMETERIES

Locality	Distance and Direction from Anna	Age of Monuments*	Max. Rotation	Per Cent Affected
Wapakoneta	12 mi. N.	New.... Old.....	0 0	0 0
Botkins (Catholic)	5½ mi. N.	New.... Old.....	10° 15°	20 40
Botkins (New Cemetery)	4 mi. N.	New	15°	35
Botkins (Old Cemetery)	4 mi. N.	Old	40°	65
Anna	(N. E. corner of village)	Old	60°	95
Anna (Old Lutheran)	1½ mi. S.	Old	30°	95
Swanders	2 mi. S.	New	15°	20
Sidney	8½ mi. S.	New.... Old.....	0 5°	0 5
McCartyville	4 mi. W.	New.... Old.....	5° 15°	5 35
Schwaberow	7 mi. W., 3 mi. N.	New.... Old.....	0 10°	0 15
New Knoxville	7½ mi. W., 7 mi. N.	New.... Old.....	0 5°	0 5
St. Patricks	6 mi. W., 2 mi. S.	New.... Old.....	0 5°	0 10
Port Jefferson	4½ mi. S., 4 mi. E.	Old	5°	10
Montra	4 mi. E., 2½ mi. N.	New.... Old.....	15° 45°	50 90
Jackson Center	6 mi. E., 3 mi. N.	New.... Old.....	10° 20°	20 35
Uniopolis	14 mi. N., 5 mi. E.	New.... Old.....	0 15°	0 20
Waynesfield.....	14 mi. N., 10 mi. E.	New.... Old.....	5° 15°	10 20

*Old monuments refer to those in which the cement between sections is virtually absent. New monuments are those erected recently and with well cemented sections at time of the earthquake.

same building pictures on the east and west walls were tilted so that the tops of the pictures sloped south after the earthquake while pictures on the north and south walls were not tilted. In the immediate environs of Anna practically all the pendulum clocks stopped regardless of the direction they faced.

Sectional monuments in the Anna cemetery showed displacement in the form of rotational movement of one section in relation to another. This rotational movement was either clockwise or counter clockwise. Table 1 shows that the degree of rotation and the number of monuments rotated was greater near Anna than in cemeteries farther away from this village. Several lighter monuments were so severely shaken that they toppled over and fell to the ground.

On the basis of the foregoing descriptions the district of greatest damage and the strongest shocks can be confined to an area of approximately 25 square miles (see Fig. 1). The village of Anna is located toward the southwest part of this elliptical area which will be referred to as the epicenter. It should, however, be remembered that such an area is only approximate and may be larger and extend farther to the northeast and southwest. The scattered farmhouses outside of the village furnished fewer observations and correspondingly less detailed study. It is gratifying to find that the epicenter located by this non-instrument method is in complete agreement with the epicenter as determined by seismic observations. The seismic studies showed the epicenter to be located approximately 90 miles due north of Cincinnati.

LESS INTENSE DISTURBANCES

The disturbances away from the area just delimited as the epicenter were obtained directly by observations of the writers or from questionnaires filled out by the families of the school children of the Anna district. The information so obtained indicates a dying out of the intensity of disturbances as the distance from the epicenter increases. The ranges of intensity have been grouped according to the numbers in the Rossi-Forel Scale and determine the positions of the isoseismic lines around the epicenter (Fig. 1). The amount of rotation of monuments and the number of monuments affected in a cemetery decreases rapidly away from the epicenter. These are tabulated in Table 1. Light objects in buildings were displaced in an irregular area of some 100 square miles around the epicenter. North

or south movements are indicated by shelfware falling to the floor from north or south facing shelves in Botkins, 5 miles north of Anna. Little or no displacement of objects was noted at Wapakoneta, 12 miles north of Anna. A few items on shelves moved north in Sidney, 8 miles south of Anna. In these areas of smaller disturbances some pictures were tilted and a few pendulum clocks, whose pendulums swung toward the epicenter, stopped.

As the distance from Anna increases property damage decreases rapidly and is generally noted only in brick chimneys or slight cracks in the walls of buildings. To avoid long descriptions these damages have been plotted on the map (Fig. 1). On this map it will be noticed that west of Anna chimneys lean east; north of Anna they lean south; at Montra, 6 miles northeast of Anna, they lean south or west; at Port Jefferson, 7 miles southeast of Anna, north or west; and at Swanders, 2½ miles south of Anna, north or east.

Before closing the discussion of the earthquake intensities some interesting sidelights of the earthquakes might be mentioned which include: change of water table as evidenced by renewed activity of springs; increased flow in wells; and conversion of ordinary wells to artesian wells. The 21 artesian wells of New Knoxville (12 miles northwest of Anna) showed increased flow after both quakes. A record kept of one of these wells shows the following variations in head:

Date	*Head*
Prior to 1931 quake	11′0″
After 1931 quake	15′7″
Prior to 1937	11′0″
After March 2, 1937, quake	15′4″
After March 9, 1937, quake	18′2″

A gas well, 19 miles east of Anna, drilled into the Trenton in December, 1936, showed a pressure of 175–200 lbs. before the first quake (March 2). After this quake the pressure was reduced to 30 lbs. and subsequent redrilling and shooting has brought no change.

GEOLOGIC CONDITIONS IN THE VICINITY OF THE EPICENTER

No bedrock outcrops are found in the Anna district because of the thick glacial debris which covers the Cedarville dolomite (Niagaran) to an average depth of 100 feet. Occasionally the

distance to bedrock is much greater in pre-glacial valleys which reach the Richmond shales at depths of 500 feet. Ver Steeg[3] has shown several narrow and deep filled valleys in the region, one of which underlies Anna and extends northwest to New Knoxville. Well drillers recognize this quarter mile wide belt as the "deep drive".

The following factors are suggested as possibly having some bearing on the location of the epicenters in the Anna district.

1. The region has experienced many (many as far as midwestern states are concerned) earthquakes in the past. These former earthquakes are listed below:

June, 1876—Intense.
September, 1889—Slight.
Summer, 1892—Intense.
?—1914—Slight.
October, 1925—Slight.
October, 1930—Moderate.
October, 1931—Slight.
March 2, 1937—Intense.
March 9, 1937—Very Intense.

It is interesting to note that at the time of the 1937 earthquakes the Anna public school carried $50,000 in earthquake insurance, a type of insurance carried by very few in Ohio or adjacent states. Since the earthquakes of March 2 and 9, 1937, several other small tremors have been felt in the Anna district, the last occurring on May 3, 1937.

2. The thickness of glacial drift beneath Anna is very great because of the presence of a pre-glacial, filled valley. When earthquakes occur buildings on loose, unconsolidated material will be more seriously affected than those built on bedrock, provided both are subjected to shocks of the same intensity. In this particular instance, however, the greatest damage is not necessarily confined to the area above the valley fill hence it follows that the damage is dependent on the location of the epicenter rather than to surficial geologic conditions.

3. The position of the epicenter may have some relation to the Cincinnati anticline but because structural studies are hampered by the thick covering of glacial drift such a relation cannot be proved or disproved. There is some faulting of considerable magnitude to the north in Wood County[4] but no faults have been found in close proximity to the epicenter.

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[3]Karl Ver Steeg: The Buried Topography of Western Ohio, Jour. Geol., Vol. 44 (1936), pp. 918–939.

[4]J. E. Carman and Wilber Stout: Relationship of Accumulation of Oil to Structure and Porosity in the Lima-Indiana Field, Problems of Petroleum Geology, Am. Assoc. Pet. Geol. (1934), (Sidney Powers memorial volume), pp. 521–529.

4. The shape of the epicenter is elliptical rather than circular with the long axis trending north-northeast. This might indicate a small linear disturbance.

5. The small size of the epicenter and the rapid decrease in intensity of the shocks away from the epicenter, as shown by the isoseismic lines, suggest that these earthquakes were of the shallow focus (10+ miles deep) rather than deep focus type.

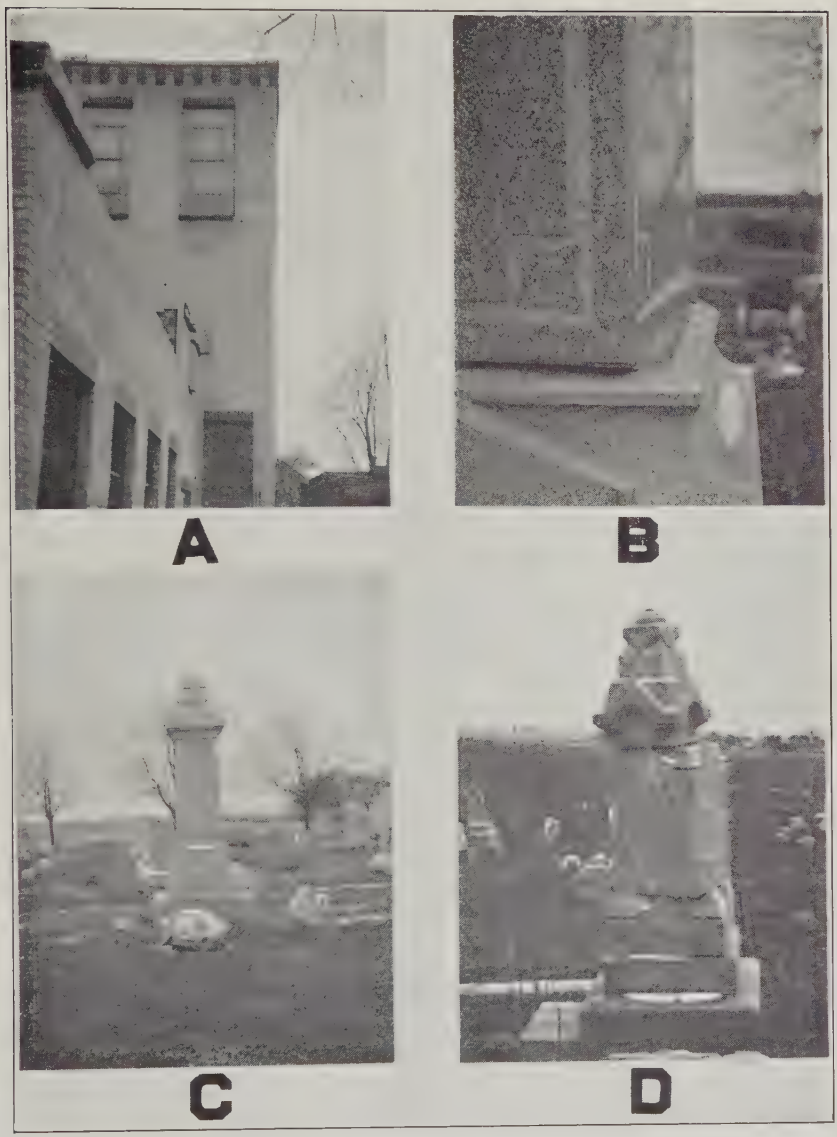
EXPLANATION OF PLATE I

A. Looking west at the northeast corner of the Anna school. Second floor portion of the wall has been displaced to the north as indicated by the cracks in the bricks and the wall pulling away from the window frame.

B. Section of recently erected monument, estimated to weigh two tons, rotated 1½ inches by the quake of March 9.

C. Ornamental urn shaken to the ground from the top of a monument in the Swanders Cemetery by the earthquake of March 9.

D. Rotational displacement of an old monument in the old Lutheran Cemetery, 1½ miles south of Anna, by the earthquake of March 2.


A
B
C
D

ALBINISM IN RANA PIPIENS (SHREBER)[1]

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Although extreme pallor (sometimes erroneously called albinism) in amphibians has been experimentally produced by the ablation of the hypophysis anlage in anuran embryos (*see* Hogben, 1927) true albinism occurs only rarely (Noble, 1931). During the spring of 1932 there appeared in the fish ponds of the Xenia Fish Hatchery at Xenia, Ohio, a number of albino tadpoles (*Rana pipiens*), a phenomenon which so far as is known, had never before occurred there. Twenty-three of these animals were successfully carried through metamorphosis (Figure 1) by isolating them in a screened portion of one of the ponds, but none was reared through the following summer (Langlois, 1933)[2]. At that time the author was doing some work on the color changes in tadpoles (Federighi, 1934) and so a request for some animals was made, but by that time all were dead.

During the spring of 1934, however, another group of albino tadpoles were noted and four specimens were brought to this laboratory where the skin was examined microscopically.

In its natural live state the tadpole is a light golden yellow, with pink eyes and no black skin pigmentation (Fig. 2) and in all external respects excepting pigmentation the animal seems normal.

Microscopic examinations of the skin shows the complete absence of melanophores (Fig. 3) indicating very clearly that the albinism is due to a lack of black pigment cells and not to melanophores with pigment in a concentrated state.

What has caused this albinism is problematical. According to Haecker (1908) the albino axolotl differs from the normally colored animal by a single Mendelian factor, and Woronzowa (1929) has reported that the implantation of pituitary tissue into the albino race of axolotl caused pigment to develop. Diet may in some cases affect pigmentation but not in this case, because albino and normal tadpoles occur side by side. It is

[1]Identified by Mr. Thomas of the Ohio State University Museum.
[2]Private communication.

interesting to speculate what may be the relative importance of each of these factors; heredity, hormones and diet. The facts that the larva goes through normal metamorphosis and, as mentioned above, that the albino animals have a common diet with normal animals seem to indicate that hormones and diet can play only a small part in this phenomenon. Thus we are forced to the conclusion that heredity is the most important if not the controlling factor. The author hopes to continue this work in order to answer these questions more fully.

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Figure 1. Adult normal and albino frogs. The albino as a tadpole was collected during the spring of 1932. Live specimens.

Figure 2. Normal and albino tadpoles. The albino was collected during the spring of 1934. Preserved specimens. The normal tadpole is *Rana catesbeiana*.

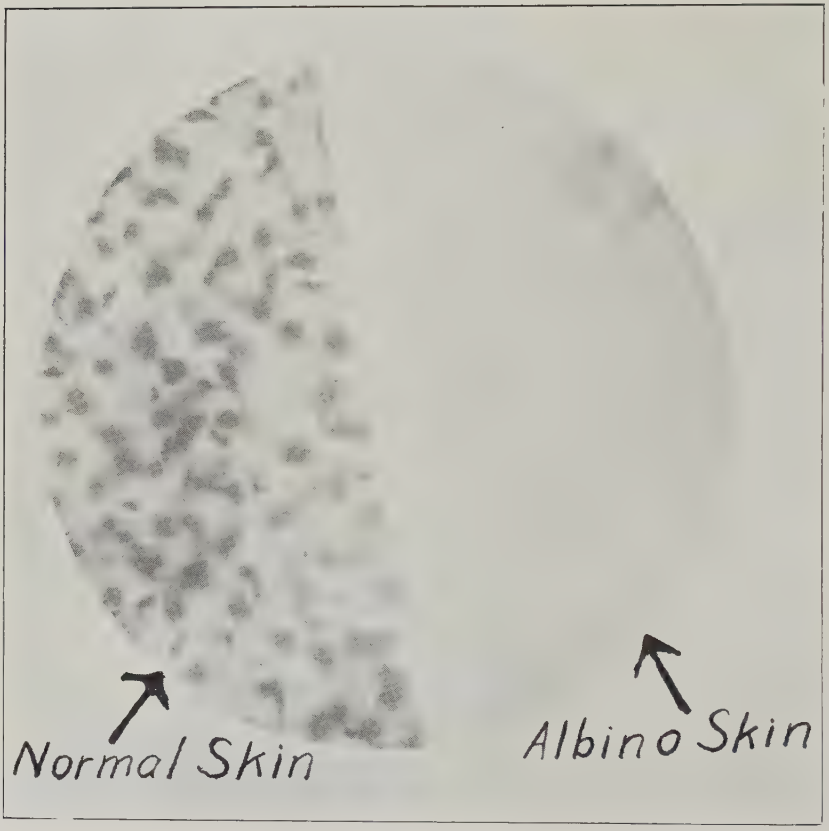

Figure 3. Photomicrograph of the tails of tadpoles shown in Figure 2. Note the entire absence of melanophores in the albino skin.

SOME NEW SPECIES OF TEXANANUS AND PHLEPSIUS FROM THE UNITED STATES

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Certain species of the Phlepsius group of genera have been confused and often two or more placed under a single name as a result of the use of external characters alone for the separation of species. The characters presented by the oedagus alone are excellent for the separation of these species and are frequently quite diverse in closely related species or two which may appear superficially to belong to the same species.

Texananus superbus Uhler

This species was described from specimens from North Carolina and Arizona. Two species were undoubtedly confused in this type series. The North Carolina specimens are therefore designated as the types and North Carolina is specified as the type locality. The oedagus is composed of three processes. The lateral pair are rather long, straight processes broadened on the basal two-thirds as seen in lateral view with the apical third tapering and decidedly narrowed. Other specimens have been examined from Tennessee and southern Illinois.

Texananus gladius n. sp.

Resembling *ovatus* in general appearance but with a long, broad, blade-like ventral oedagus process. Length, 5 mm.

Vertex bluntly angled, two-thirds as long on middle as width between eyes at base.

Color: Vertex, pronotum and scutellum yellowish, a pair of dark spots on disc of vertex. Elytra heavily marked with ramose pigment lines, posterior margin along scutellum and commissural line pale.

Genitalia: Female last ventral segment broadly, shallowly excavated with a short V-shaped notch at center. Male valve short, broadly triangular, male plates broader than long, broadly rounded. Oedagus composed of a dorsal process which is twice curved concavely upward. The caudal half more strongly curved with a slender upturned apex. Ventral portion protruding beyond apex of abdomen. In lateral view broad, blade-like and slightly concave upward.

Holotype male from Huachuca Mts., Arizona, August 18, 1936; allotype female, Gillespie Co., Texas, June 14, 1934, and male and female paratypes, Gillespie Co., same date, all collected by J. N. Knull, are in the author's collection.

Texananus angus n. sp.

Resembling *superbus* in form and appearance but narrower, paler in color and with more slender lateral processes in oedagus. Length, 6–6.5 mm.

Vertex as in *superbus* roundly angulate, produced, one-third longer on middle than next the eyes.

Color paler than in *superbus*. Ramose lines on elytra pale and fewer in number. Dark marking at end of claval veins paler.

Genitalia: Female last ventral segment broadly angularly excavated almost to base. Male valve short, narrow, and rounded. Plates broad, rather short and bluntly pointed at apex. Oedagus with three processes as in *superbus* but side processes shorter and much narrower in lateral view. Pygofers shorter and more rounded at apex.

Described from a series of male and female specimens from Uvalde, Texas, May 23, 1935; Gillespie Co., Texas, May 2, 1935, collected by J. N. Knull; Wellington, Kansas; and Roff, Cheyenne, Elser, Lebanon, and Page, Oklahoma, collected by Standish and Kaiser.

Holotype male, Uvalde, Texas; allotype female, Cheyenne, Oklahoma, and male and female paratypes in author's collection.

Texananus vermiculatus n. sp.

Resembling *superbus* in form and coloration but with long vermiculate forked lateral processes on oedagus. Length, 6 mm.

Vertex produced, blunt, rounded, almost twice as wide between eyes as median length.

Color: Yellow reticulate with brown, three brown spots on disc of scutellum and posterior ends of claval veins black.

Genitalia: Female last ventral segment rather long, deeply rather sharply excavated almost to base forming a V-shaped notch which is widened at apex. Male valve broadly triangular, male plates broad, strongly rounded to slightly pointed apices. Oedagus with three processes. The central process is short and curved dorsally, the lateral processes are long curved dorsally then ventrally at apex. A short, branched process arises at about one-third the distance to apex.

Holotype male and allotype female, Chiricahua Mts., Arizona, July 14, 1936, by J. N. Knull. Paratypes same place and date. Also from Davis Mts., Texas, August 22, 1936; Tucson, Arizona, July 27, 1936, and Wickenburg, Arizona, July 8, 1937, all collected by J. N. Knull, and in the author's collection.

Texananus manus n. sp.

Resembling *superbus* in general form and appearance but with broadened apices on lateral processes of male oedagus. Length, 6.5 mm.

Vertex produced and bluntly angled, two-thirds as wide between eyes as median length.

Color paler than *superbus* with black markings at ends of claval veins along posterior margin of elytra.

Genitalia: Male valve triangular with blunt apex, plates broad, rounded, pygofers longer than plates. Oedagus with a central dorsal

process as in *superbus*, lateral processes wide and in lateral view with apices broadened and notched producing finger-like processes which extend dorsally, ventrally, and caudally.

Described from a series of male specimens from Hualpai Mts., Arizona, July 4, 1937, collected by D. J. and J. N. Knull; Huachuca Mts., Arizona, June 9, 1935, by J. N. Knull; and one specimen labeled California without date.

Holotype male, Hualpai Mts., and male paratypes in author's collection.

Phlepsius rossi n. sp.

Resembling *fulvidorsum* in color and general appearance but slightly larger and with distinct genitalia in both sexes. Length, 7.5 mm.

Vertex produced and bluntly angled, one-half longer on middle than next the eyes, margin of vertex sharply angled with front.

Color: Vertex, pronotum and scutellum buff or dull yellow. Vertex rather heavily irrorate with brown on margin at apex and either side of middle. Pronotum rather heavily irrorate, especially on disc. Scutellum scarcely irrorate, two conspicuous brown spots on lateral margin at either side. Elytra pale, heavily irrorate, appearing brown. Inner ends of anterior claval veins white along commissural line.

Female last ventral segment rather long, posterior margin produced and margined with brown either side of a rather broad, shallow V-shaped notch. Male valve triangular, plates long, gradually tapering to narrow blunt apices. Oedagus in ventral view rather broad, apical half directed dorsally, apex with four terminal slender processes. The central pair are long and form the terminal portion of the oedagus, the lateral pair are short. A heavy process arises at the apex of each pygofer and curves across the opposite side, the apex of which is enlarged and bears a spine which extends ventrally and anteriorly.

Described from a series of one female and five male specimens collected at Herod, Illinois, August 4, 1934, by H. H. Ross, C. O. Mohr and the author, and one male specimen collected at Portland, Connecticut, July 24, 1921, by B. H. Walden. Male holotype, Portland, Connecticut, and male paratype in author's collection. Female allotype and male paratypes from Herod, Illinois, in Illinois Natural History Survey Collection.

I take pleasure in dedicating this species to Dr. H. H. Ross.

Phlepsius electus n. sp.

Resembling *irroratus* in size and general appearance, but paler in color and with distinct male genitalia. Length, 5 mm.

Vertex produced and bluntly angled, one-half longer at middle than next the eyes. Margin thin, vertex sharply angled with front.

Color: Vertex, pronotum and scutellum cream colored, rather evenly mottled with light brown. Elytra white, sparsely irrorate with dark brown.

Genitalia: Male valve broadly triangular, plates about as long as combined width at base, gradually tapered to blunt apices. Oedagus with a ventral and dorsal portion. The ventral portion in lateral

view is narrow at base and strongly abruptly broadened on apical third with a short dorsal process at apex. The dorsal portion is directed dorsally at base, then curved posteriorly and consists of two lateral pieces which diverge at apex and exceed the ventral portion in length. Pygofer with a short, erect spine on dorsal apical margin, either side.

Described from two male specimens collected in Shannon Co., Missouri, September 8, 1930, and Apple River Canyon State Park, Illinois, July 11, 1934, the latter by T. H. Frison and the author.

Holotype male (Missouri) in author's collection. Paratype male, Apple River Canyon, Illinois, in Illinois Natural History Survey collection.

Phlepsius certus n. sp.

Resembling a pale *irroratus* in general appearance but with vertex more evenly rounded and oedagus entirely different in form. Length, 5.5 mm.

Vertex almost parallel margined, three times as wide between eyes as median length, bluntly angled with front.

Color dull yellow, rather evenly marked by pale ramose pigment lines. Two darker spots along posterior margin of elytra. One is located at end of claval suture and one about half way between this and apex of scutellum.

Genitalia: Male valve short, broadly bluntly angled. Plates long, broad at base, slightly concavely narrowed about half way to apex which is bluntly pointed. Oedagus in lateral view curved upward near base, then bifurcate, a short process extending dorsally and a broad longer process directed caudally, the latter narrowed near apex. Pygofers with a long spine at the ventral caudal margin of each which is directed dorsally.

Holotype male, Wingra Lake, Wisconsin, July 8, 1916, collected by H. K. Harley, in the collection of the author.

Quantum Mechanics

In his new book which consists of five parts in addition to a preface and a chapter of introduction, Professor Lande has given what must be acknowledged as a clear and concise discussion of the principles of quantum mechanics. In the preface is stated the general purpose of the work and acknowledgment is made to the sources (especially Heisenberg's "The Physical Principles of the Quantum Theory") from which certain of the illustrations are drawn. Part I is expended to the elementary theory of observation or the principle of complimentarity and use of the principle is made to obtain the laws of quantum mechanics. Part II concerns itself with Heisenberg's uncertainty principle, while Part III is devoted to the principle of interference and to the equation of Schrödinger. The fourth part gives a development of the transformation theory as applied to quantum mechanics and considers the relation of the quantum mechanics to classical mechanics. In the mathematical appendix which constitutes Part V, the author treats the invariance of the matrix elements of quantum mechanics to canonical and unitary transformations.

Because of simplicity and clarity of style, Lande's "Principles of Quantum Mechanics" can enthusiastically be recommended to students who desire to obtain a knowledge of the underlying principles of the theory.—*H. H. Nielsen.*

Principles of Quantum Mechanics, by Alfred Lande. xii+117 pp. New York, The Macmillan Co., 1937. $2.25.

A NEW CIXIUS FROM OHIO
(HOMOPTERA: FULGORIDAE)

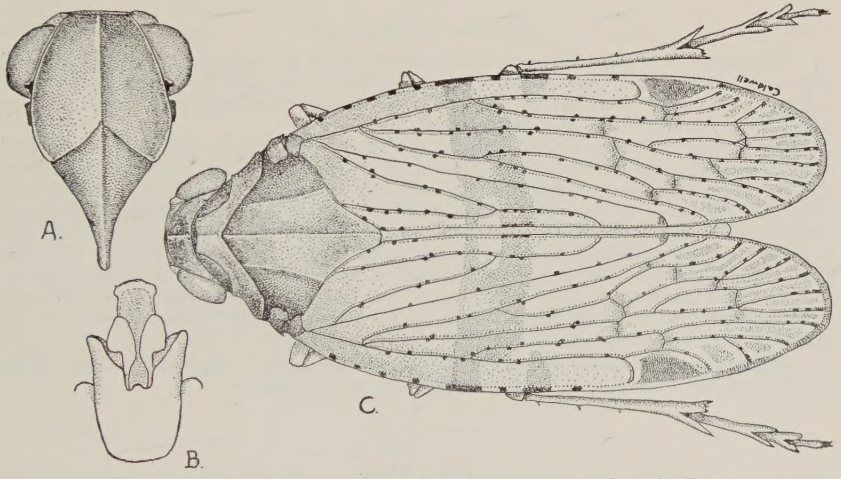
JOHN S. CALDWELL
Ohio State University

Cixius angustatus n. sp.

Length to tip of forewing, 5.2 mm.; forewing, 4.5 mm.

Vertex transverse, arcuate on both cephalic and caudal margins, resembling *pini* and *guttulatus*, median length equal to about one-third width at middle of caudal margin; median carina present. Frons broader than median length; prominent median carina present. Pronotum with median carina; caudal margin obtusely angled. Mesonotum with three prominent carinae; lateral carinae divergent caudally.

Caudal margin of pygofer broadly rounded in lateral aspect; ventral sinus broadly concave around small median tooth. Styles similar to *stigmatus* in ventral aspect except less broadened apically; broadly truncate on apical half of dorsal margins in lateral aspect. Anal segment narrow, short.



A.—Ventral view of face. B.—Ventral view of genitalia.
C.—Dorsal view of entire specimen.

General color blackish. Median carina of front yellowish; clypeus and frons concolorous; vertex black except white spot on either side next to eyes. Pronotum blackish fuscous; carinae slightly lighter; carinae of mesonotum and area between dark brown, rest of mesonotum black. Femora and tarsi dark fuscous; tibiae pale. Forewings milky hyaline, fumed basally, especially along costal margins; center of apical cells strongly fumed; a transverse band present about half way to stigma, broadening toward commissural margin; veins with dark punctures.

Male holotype from Scioto Co., Ohio, May 10, 1935, is in the writer's collection at Ohio State University.

BOOK NOTICES

Elementary Chemistry

The idea stated in the preface that this book results from a course "developed to emphasize the applications of chemistry, and designed to meet the need of the student who desires the chemical fundamentals in practical form" has been closely followed throughout the text. For special groups of students needing only a realization of the relationship between chemistry and their chosen profession, the work is excellent. As might be expected, the book does not consider to any extent the principles involved in most of the discussion. For that reason it would be very unsuitable for a general course in chemistry. The first half of the book deals with the fundamental nature of matter, inorganic substances, water, acids, bases, salts and solutions. The latter half discusses the important practical points about organic and physiological chemistry under the topics carbon and its compounds, foods and digestion, body fluids, textiles and cleaning of materials. This part is of especial value for nurses. The book is well printed on fine paper and well bound. The number of illustrations is small but well chosen.—*L. L. Quill.*

Elementary Chemistry, by Imo P. Baughman. 296 pp. Philadelphia, Lea and Febiger, 1937. $2.75.

Physics for Engineers

This work is a third edition of a physics text of the same name and is divided into two volumes; the first on Mechanics and Heat, suitable for a first semester of college physics for engineering students; the second, treating Sound, Electricity and Light, suitable for a second semester.

This work is quite lucidly written, plentifully illustrated with diagrams and actual photographs and demands no further mathematical equipment beyond the algebra. As the title implies, this work is especially suitable for students of technical subjects; many practical applications of the principles set forth being emphasized. The subject matter is, however, strictly classical physics; while the reviewer is fully conscious that little time is available in a course of this type for discussion of modern physics, it still seems unfortunate not to give to engineering students also a feeling of what modern physics treats and what its possible importance might be also in technical fields. Aside from this detail the work appeals to the reviewer and is sincerely recommended.—*H. H. Nielsen.*

Physics for Technical Students, by W. B. Anderson. 3rd ed., 2 vols. New York, The McGraw-Hill Book Co., 1937. $2.50 per volume.

Early Man

Laymen, scientists in other fields and even anthropologists themselves tend to feel confused and quickly "behind the parade" as the evidence concerning man's origin and early development rapidly accumulates. To all such persons, scientifically interested in the problems of human antiquity, this book is heartily recommended. It consists of the papers read before the International Symposium on Early Man held last March on the occasion of the 125th anniversary of the founding of the Philadelphia Academy of Natural Sciences. Thirty-five leading authorities, all actively engaged in actual field research, from all parts of the world, have contributed highly condensed reports of their latest researches and views. Consequently the volume contains a survey of scores of articles previously printed in many languages as well as a wealth of previously unpublished material. Sir Arthur Keith, the eminent British anatomist, carried the burden of summarizing such material for twenty years in his series of works dealing with human antiquity, the latest of which, "Recent Discoveries Relating to the Antiquity of Man," appeared in 1931. The subject has now progressed beyond the powers of any one man's

efforts, I believe, and it is to be hoped that volumes such as the present one will appear in the future at intervals of not less than five years.

The present reviewer's only serious complaint has to do with the grouping of the contributions in the book by chronological order of presentation rather than by subject. For instance, it would have been more helpful to have placed the three articles dealing with recent finds in Java together, rather than scattering them, as is the case, at pages 23, 315, and 349, respectively.

The question of man's origin and early life is as yet imperfectly understood. But the search for evidence and the interpretation of the available data form a fascinating field of research which may yet, by clarifying our past, illuminate our present and future.—*J. P. Gillin.*

Early Man, edited by George Grant MacCurdy. 362 pp. Philadelphia, J. B. Lippincott Co., 1937. $5.00.

Atomic Physics

This second edition supersedes the first edition known under the title "Atomic Physics" and is a text useful for students whose knowledge of physics is limited to that gained from the general course. In it the authors have seen an opportunity to rectify and improve much of the material in the former presentation and to include also discussions concerning more recent developments in physics.

Like its predecessor this volume discusses from an elementary point of view such subjects as kinetic theory, the atomic nature of electricity and radiation, atomic and molecular spectroscopy, earlier and later quantum theory, relativity and astrophysics. A chapter is, however, added in this second edition which is devoted to nuclear physics and more recent experiments on the nature of cosmic rays. While the second edition has been improved and modernized in many places, unfortunately certain other places remain out of date. For example, as an illustration of the spectrum of a diatomic molecule is given the curve of Elmer Imes. It would seem only natural to include the much more recent curve of Meyer and Levin in which complete resolution of the spectrum was accomplished.

The preparation of a text on Modern Physics for a class of students of the calibre for which this book is intended is no doubt a difficult one. This work is probably as good a one as is available, although it must be conceded that to avoid the use of mathematics a great deal of the clarity and accuracy has had to be sacrificed.—*H. H. Nielsen.*

An Outline of Atomic Physics, by O. H. Blockwood, E. Hutchisson, T. H. Osgood, A. E. Ruark, W. N. St. Peter, G. A. Scott and A. G. Worthing. 2nd ed. x+414 pp. New York, John Wiley and Son, 1937. $3.75.

A Modern Darwin

To this reviewer the new volume by Dobzhansky appears to be the most significant biological book of the past quarter-century. It is a thorough exposition of the implications for evolution arising from modern genetic theory. Since Darwin, himself, was one of the very few whose major interests lay in studies of the mechanism of evolution rather than in the historical problem, genetics rather than evolutionary morphology is heir to the Darwinian traditions. The book thus treats mainly of the dynamics of evolution. The three levels of evolutionary progress are carefully discussed: first, the occurrence of mutations and chromosomal aberrations; second, their fate as determined by the dynamic regularities of the physiology of populations; and third, the fixation of the diversity already attained on the preceding two levels. "Position effects" are treated in detail. There is a thorough discussion of the effects of random variations of gene frequencies. Here the conclusion is reached that the differentiation of a species into races may take place apart from the action of natural selection. This does not at all invalidate natural selection as an evolutionary agency, however. A chapter is devoted to hybrid sterility, and the book closes with a discussion of species as natural units. The author uses beautiful English, and has an exceptionally clear and readable style.

Because of his Russian birth and education, he has made available in the book much literature which might not otherwise reach an American audience. Illustrations are provided where needed, and a fairly complete list of citations is appended.
—L. H. S.

Genetics and the Origin of Species, by Theodosium Dobzhansky. xvi+364 pp. New York, Columbia University Press, 1937. $3.60.

Thermodynamics

This is a text book admirably suited for use in an intermediate course for students preparing themselves for careers in physics, chemistry or engineering. The background required for the comprehension of the subject matter by the student, as it is here presented, is limited to a course in general college physics and one in the calculus. In this respect the author is quite zealous, all mathematical equipment not contained in the calculus being derived when the demand for it arises. The first half of this book treats the fundamental concepts of thermodynamics; for example, temperature, the first and second laws of thermodynamics, work and heat, reversibility and irreversibility and entropy. The second half has as its purpose the application of the general principles discussed in the first half to certain specific problems in physics, chemistry and engineering as the heat engine and the refrigerator, the Joule-Kelvin effect, thermo-electric phenomena and phase change. This work is useful to the beginning student in that the subject matter is treated in much more detail than is customary, most of the intermediate steps being retained. Probably in no manner can the importance of the principles set forth so well be emphasized as by the actual solution of examples depending upon them. A most commendable feature of this book is the complete list, at the end of each chapter, of examples suitable for classroom discussion. Quite enthusiastically and without reservation can this book be recommended to the college teacher as actually doing what it sets out to do.—**H. H. Nielsen.**

Heat and Thermodynamics, by Mark W. Zemansky. xii+388 pp. New York, the McGraw-Hill Book Co. 1937. $4.00.